# Theme:
# Structure and function of DNA (primary and secondary)

**Lesson objectives:**

- Establish the connection between DNA structure and its function;
- Describe the chemical structure of nucleotides and explain their bonding and location in DNA molecules;

# Creating an information scheme that should describe the structure and function of DNA

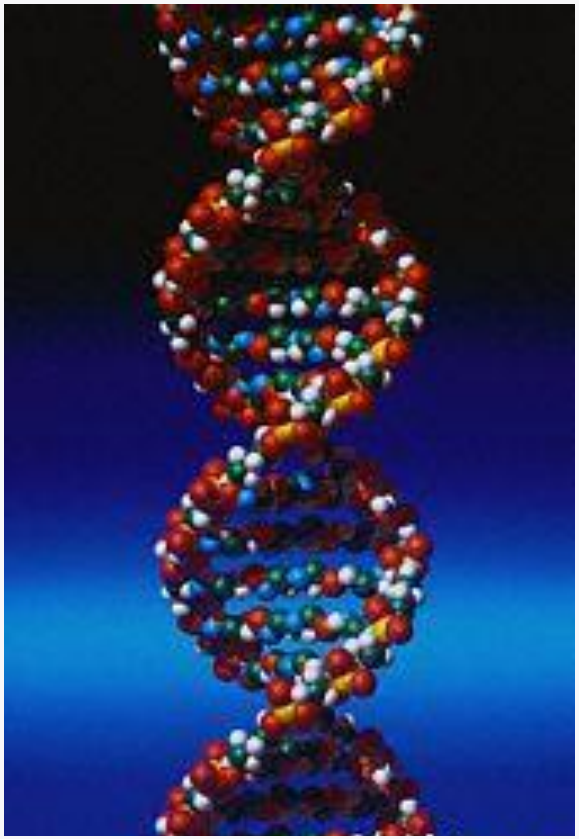
# Compare your schema with video info

- https://www.youtube.com/watch?v=o_-6JXLYS-k

# Why do we study **DNA**?

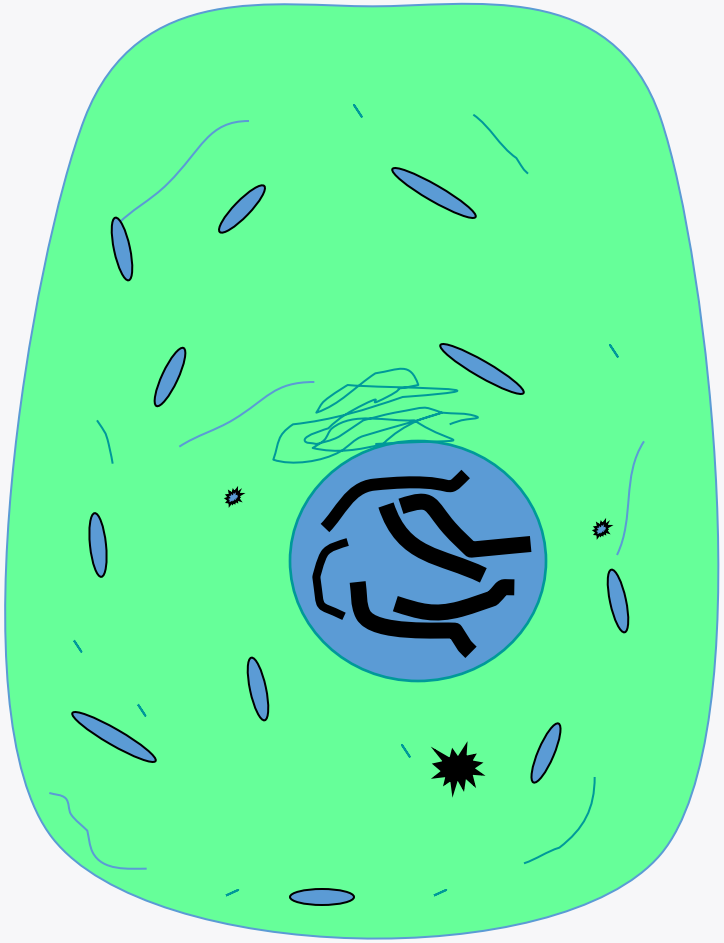
**We study DNA for many reasons, e.g.,**

- **its central importance to all life on Earth,**
- **medical benefits such as cures for diseases,**
- **better food crops.**



# Chromosomes and DNA

- Our genes are on our chromosomes.
- Chromosomes are made up of a chemical called DNA.

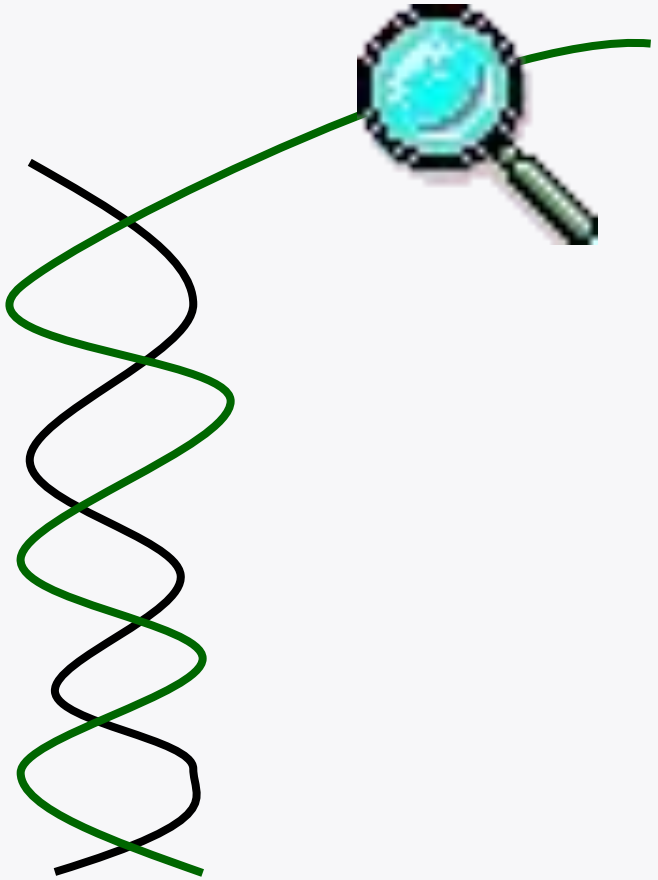


# The Shape of the Molecule

- DNA is a very long polymer.
- The basic shape is like a twisted ladder or zipper.
- This is called a *double helix.*

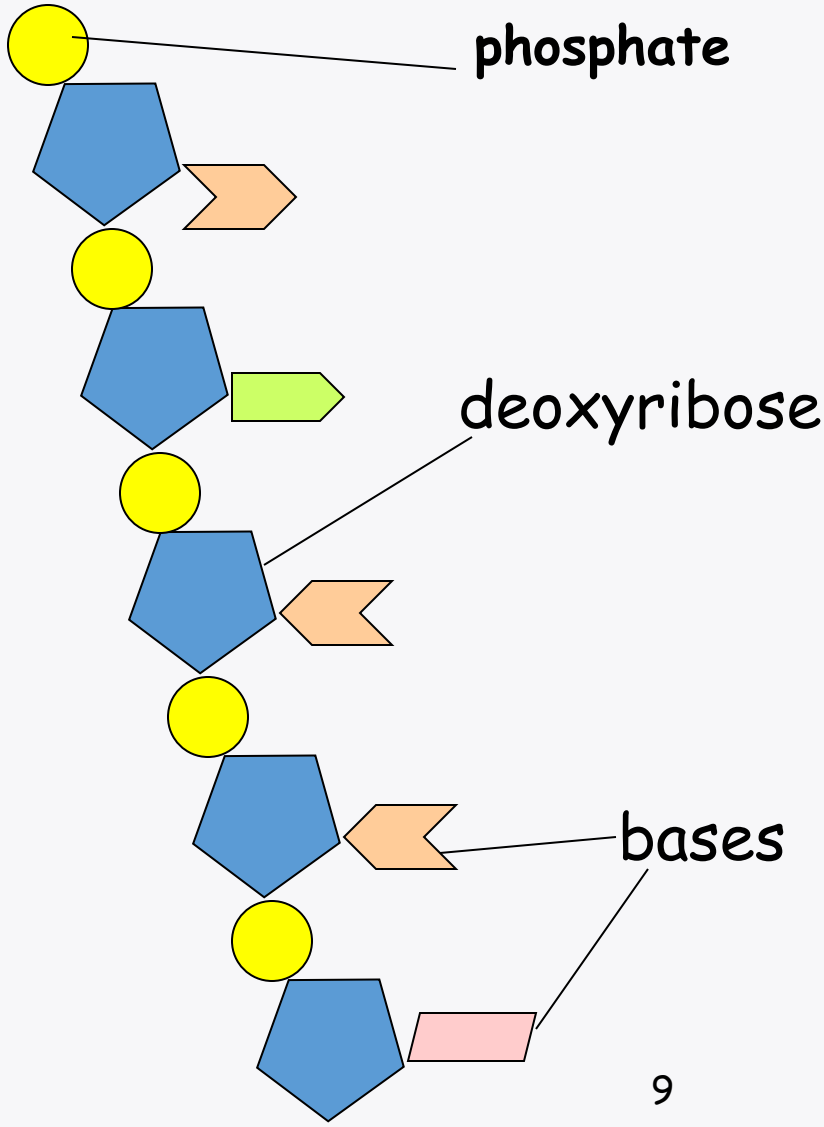
# The Double Helix Molecule

- The DNA double helix has two strands twisted together.

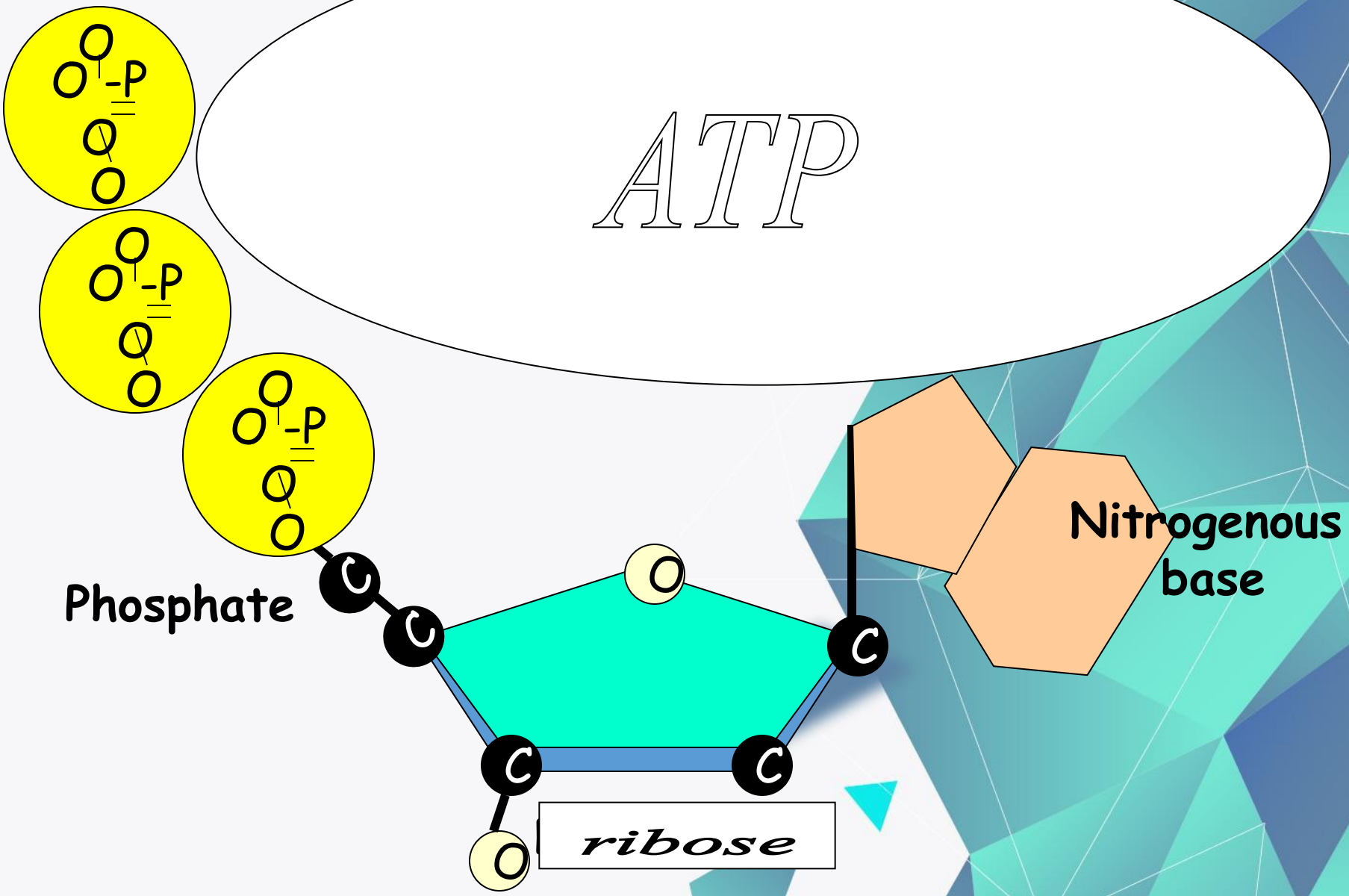


# One Strand of DNA

- The backbone of the molecule is alternating phosphates and deoxyribose sugar
- The teeth are nitrogenous bases.

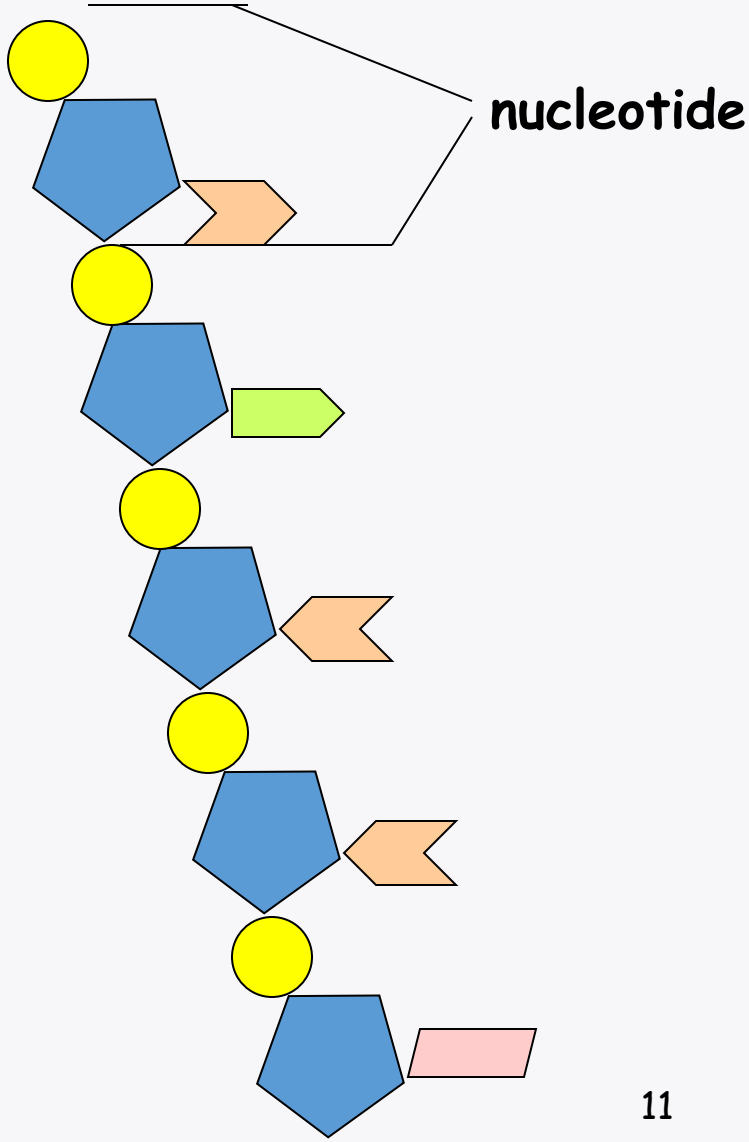


# ATP



# One Strand of DNA

- One strand of DNA is a polymer of nucleotides.
- One strand of DNA has many millions of nucleotides.



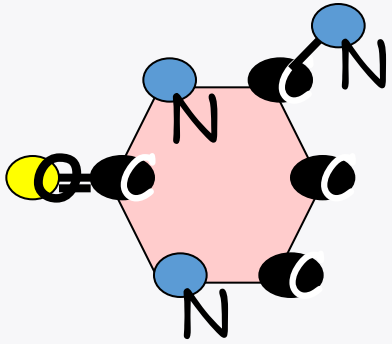
# Four nitrogenous bases

**DNA has four different bases:**

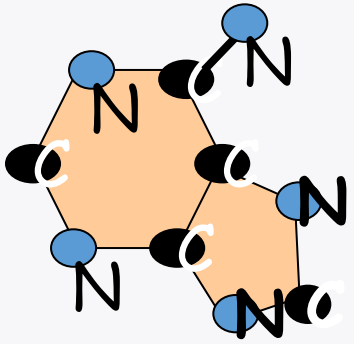
- Cytosine **C**
- Thymine **T**
- Adenine **A**
- Guanine **G**

# Two Kinds of Bases in DNA

- *Pyrimidines* are single ring bases.

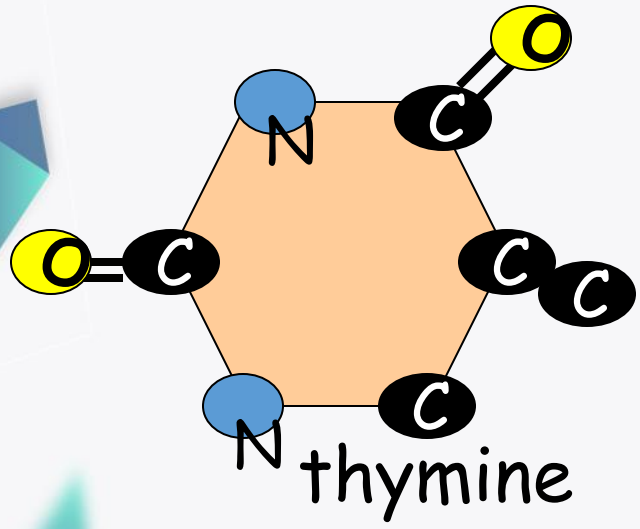



- *Purines* are double ring bases.

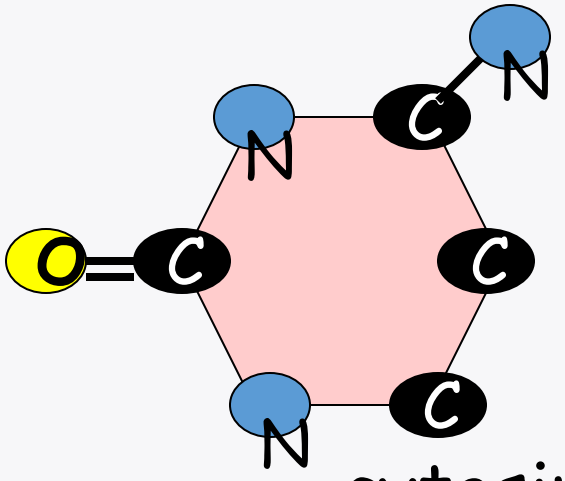


# Thymine and Cytosine are pyrimidines

- Thymine and cytosine each have one ring of carbon and nitrogen atoms.



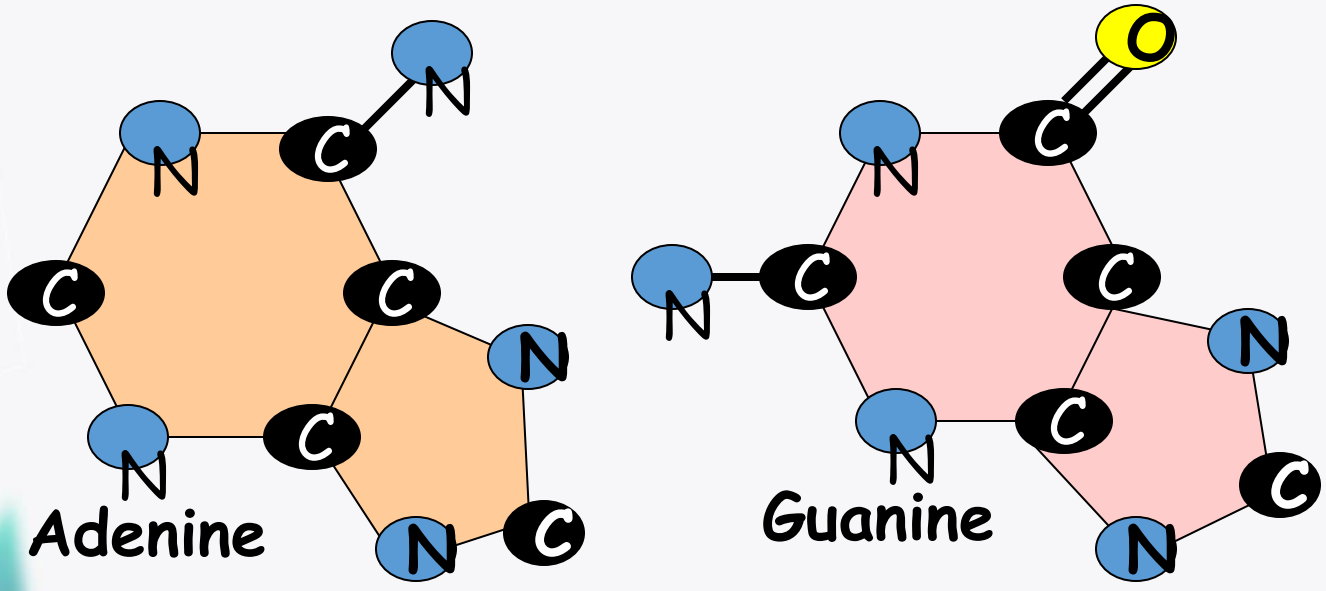
thymine



cytosine

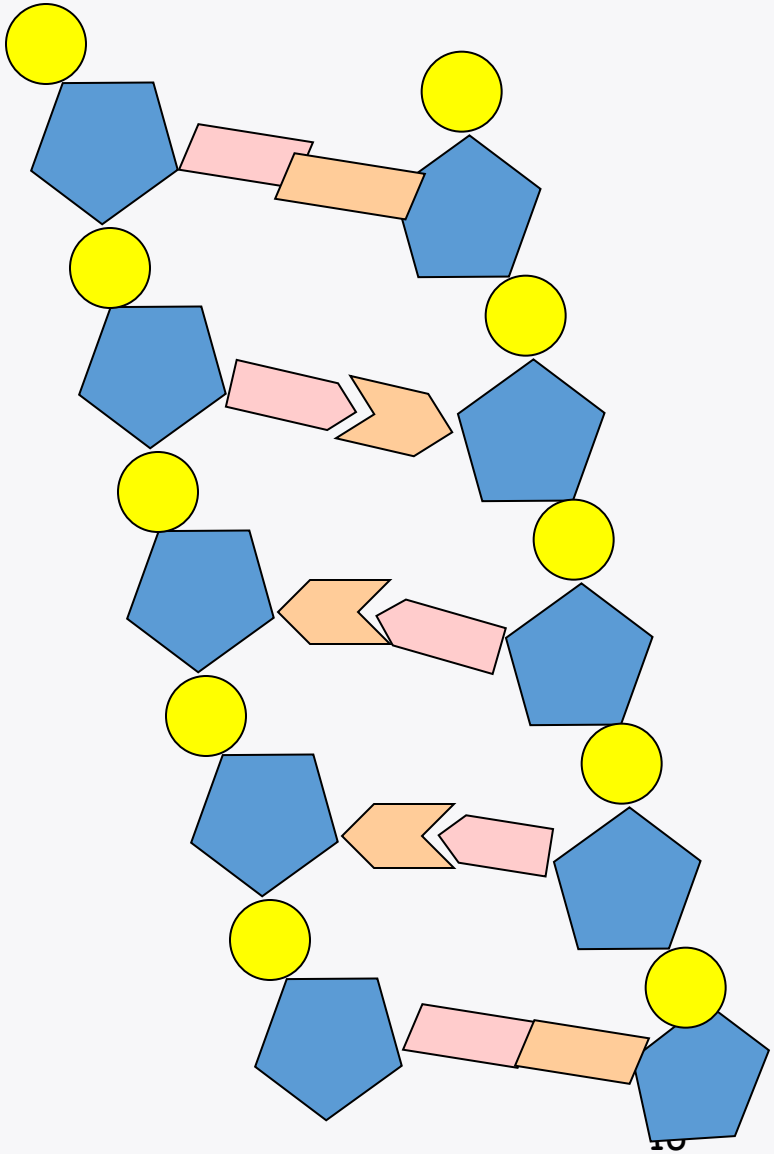
# Adenine and Guanine are purines

- Adenine and guanine each have two rings of carbon and nitrogen atoms.



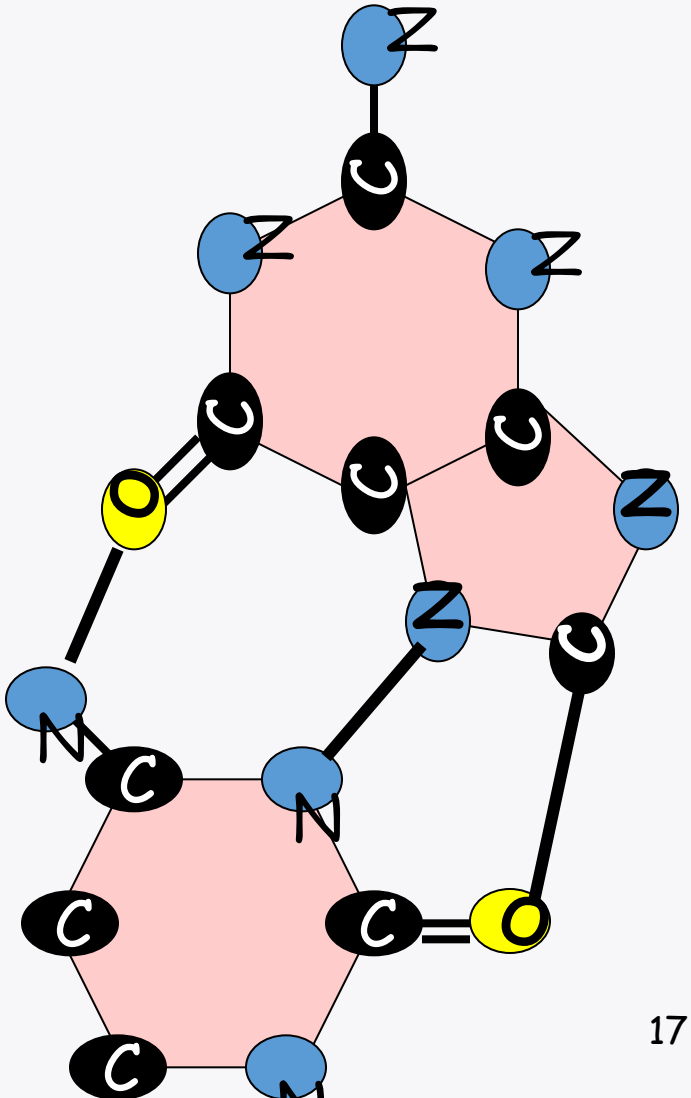
# Two Stranded DNA

- Remember, DNA has two strands that fit together something like a zipper.
- The teeth are the nitrogenous bases but why do they stick together?



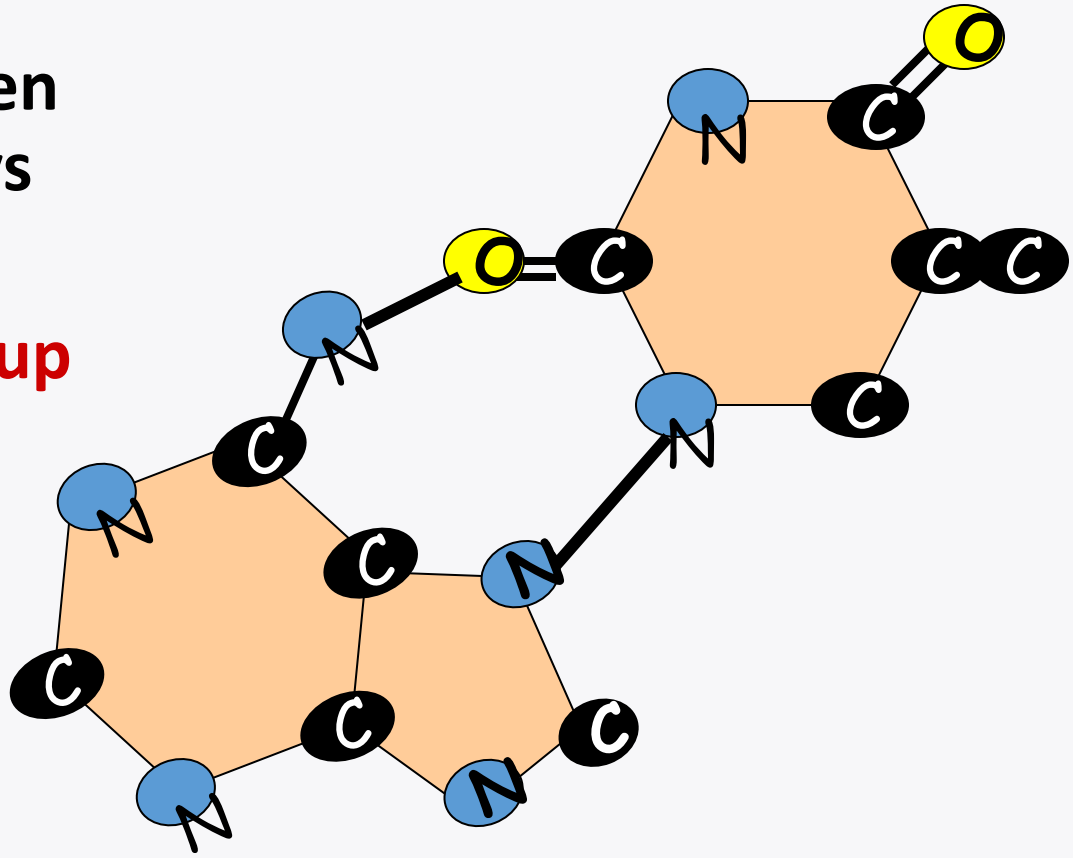
# Hydrogen Bonds

- The bases attract each other because of hydrogen bonds.
- Hydrogen bonds are weak but there are millions and millions of them in a single molecule of DNA.
- The bonds between cytosine and guanine are shown here with dotted lines



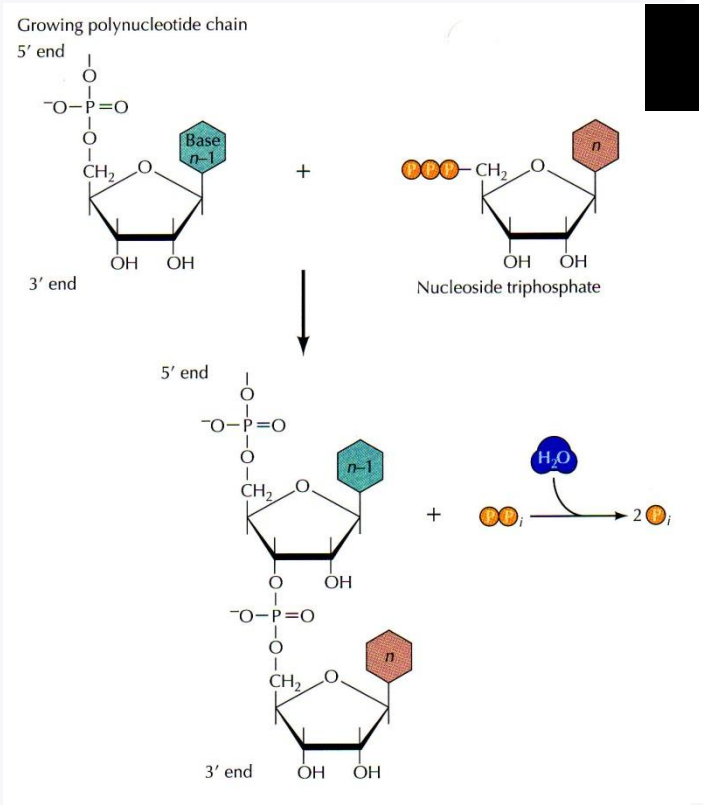
# Hydrogen Bonds, cont.

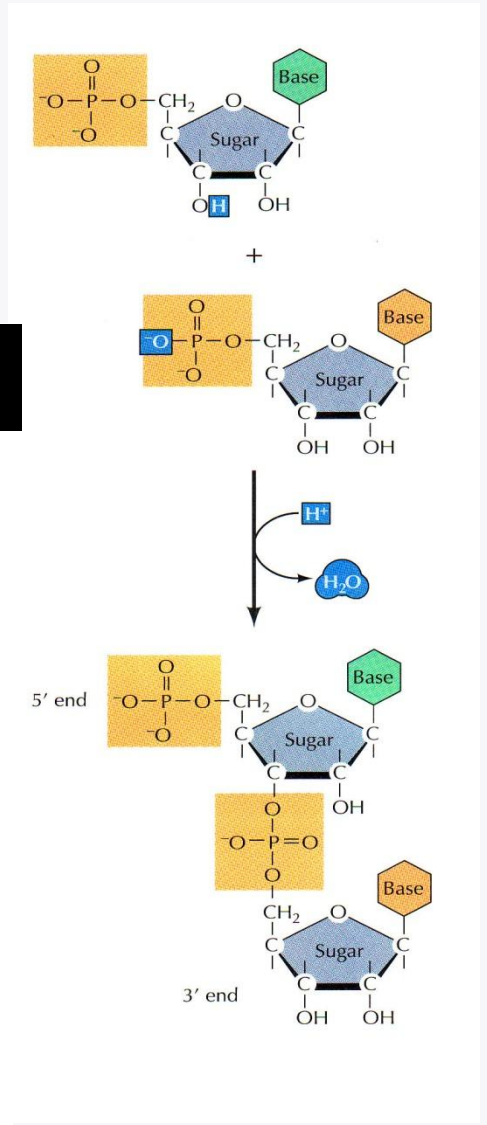
- When making hydrogen bonds, cytosine always pairs up with guanine
- Adenine always pairs up with thymine
- Adenine is bonded to thymine here



# Linear Polymerization of Nucleotides

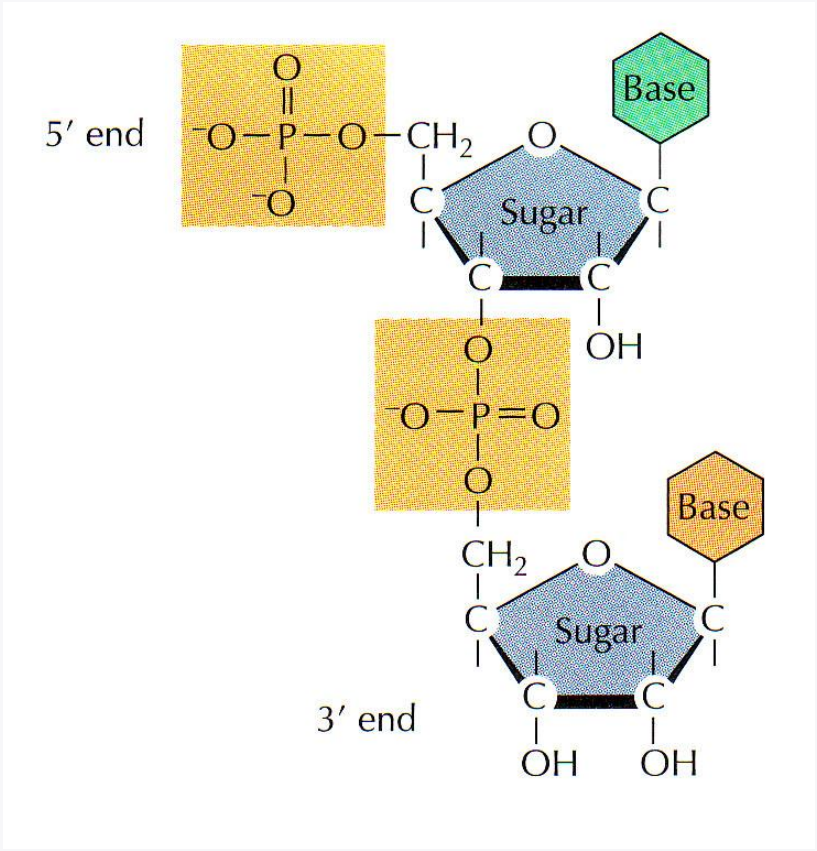
- Nucleic acids are formed of nucleotide polymers.
- Nucleotides polymerize together by ***phospho-diester bonds*** via condensation reaction.
- The phospho-diester bond is formed between:
  - Hydroxyl (OH) group of the sugar of one nucleotide.
  - Phosphate group of other nucleotide



# Polymerization of Nucleotides

- The formed polynucleotide chain is formed of:
  - Negative (-ve) charged Sugar-Phosphate backbone.
    - Free 5’ phosphate on one end (5’ end)
    - Free 3’ hydroxyl on other end (3’ end)
  - Nitrogenous bases are not in the backbone
    - Attached to the backbone
    - Free to pair with nitrogenous bases of other polynucleotide chain



# Polymerization of Nucleotides

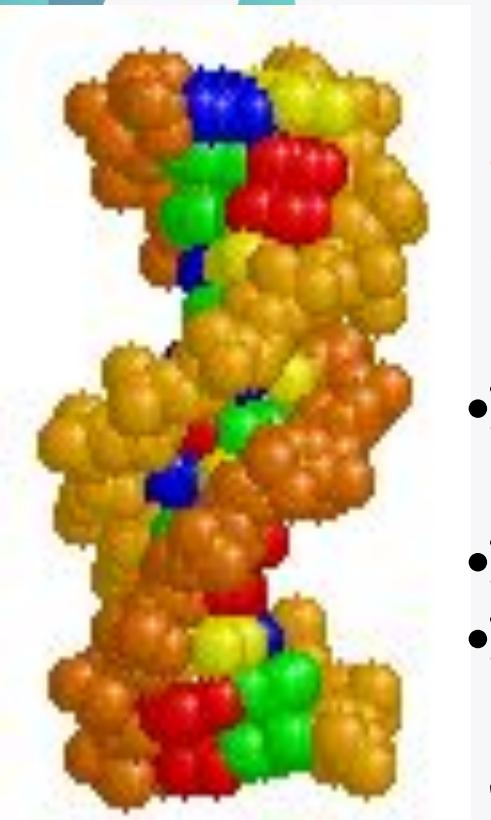
- **Nucleic acids are polymers of nucleotides.**
- **The nucleotides formed of purine or pyrimedine bases linked to *phosphorylated sugars* (nucleotide back bone).**
- **The bases are linked to the pentose sugar to form *Nucleoside*.**
- **The nucleotides contain one phosphate group linked to the 5' carbon of the nucleoside.**

**Nucleotide = Nucleoside + Phosphate group**

# DNA by the Numbers

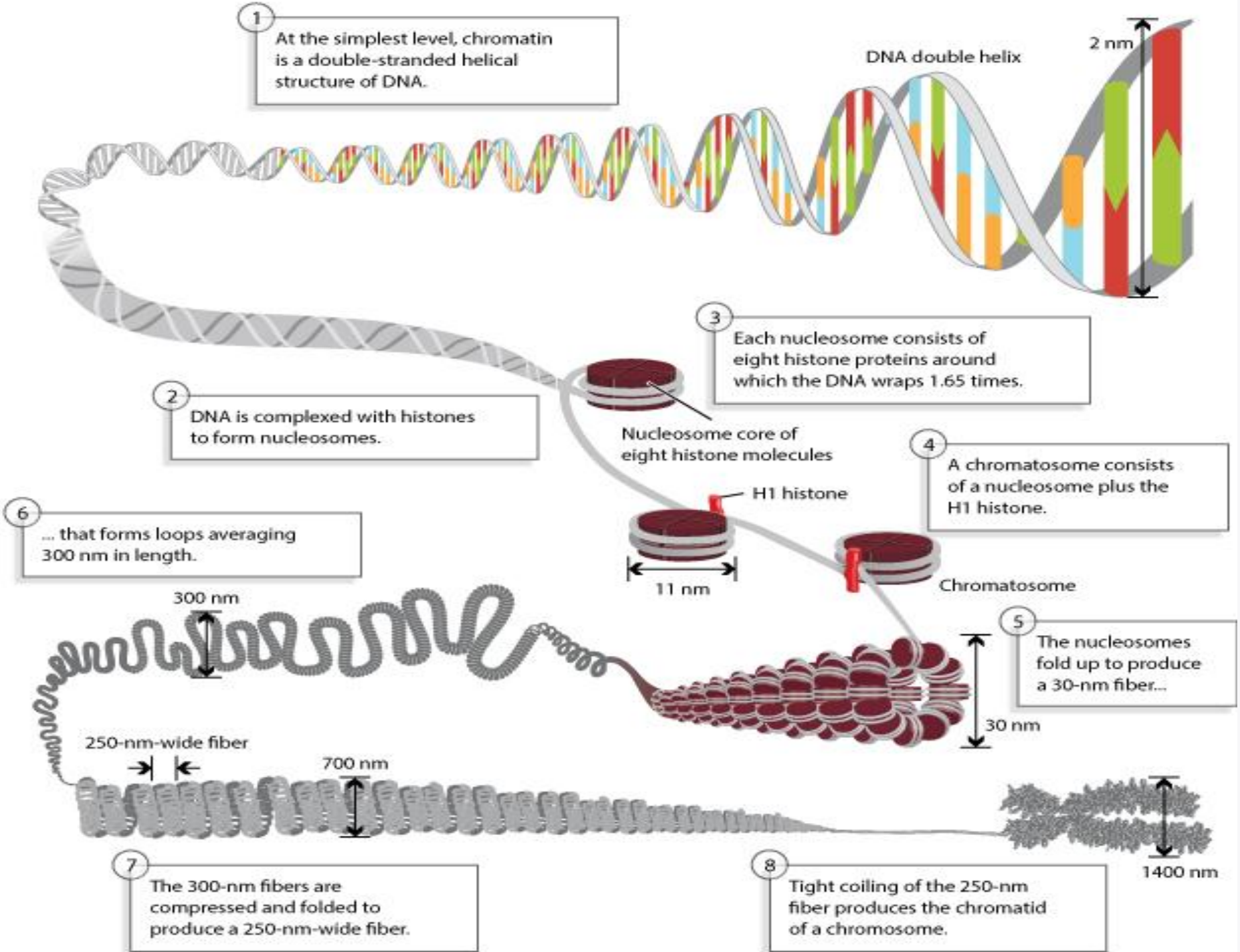
- Each cell has about 2 m of DNA.
- The average human has 75 trillion cells.
- The average human has enough DNA to go from the earth to the sun more than 400 times.
- DNA has a diameter of only 0.000000002 m.


The earth is 150 billion m or 93 million miles from the sun.

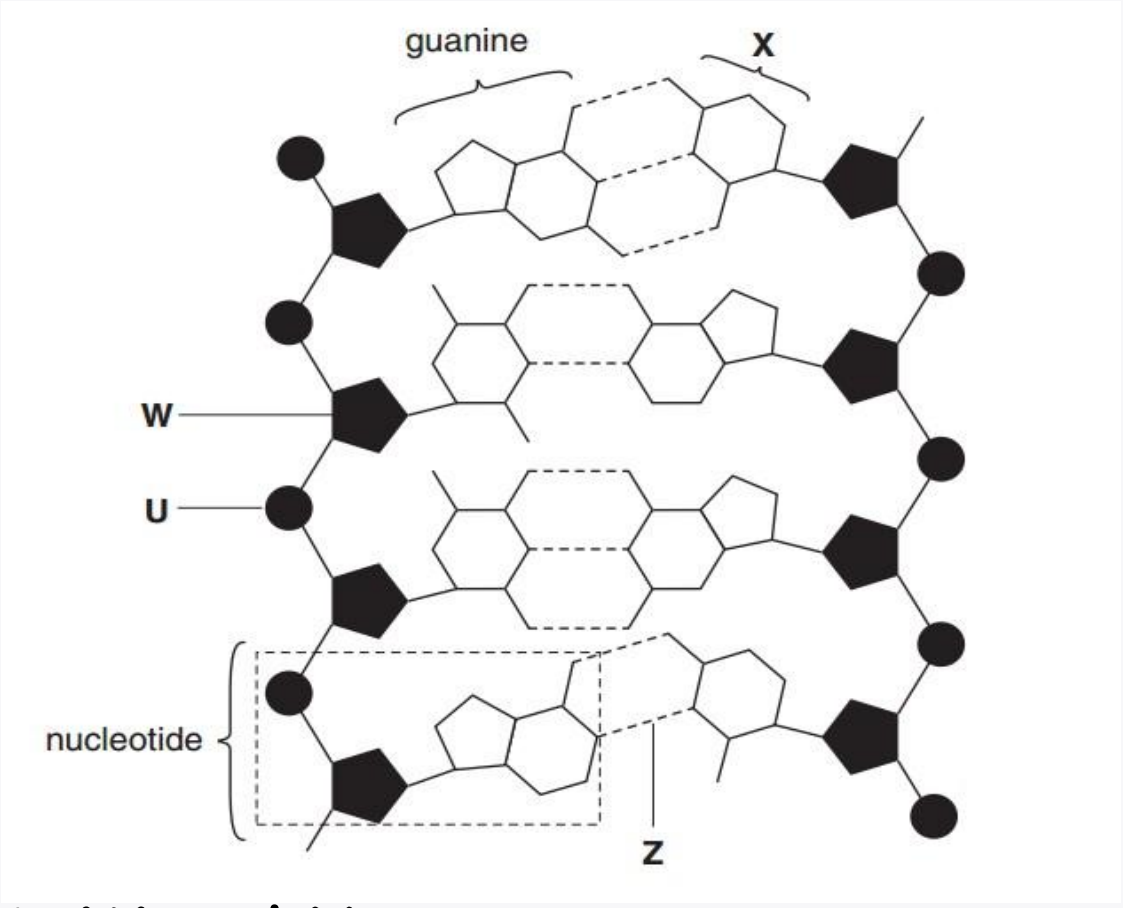


# Summary of how DNA Structure is suited to function:

- It is very stable: nucleotide are linked by covalent bonds.
- It Carries coded information.
- It can be replicated: specific base pairing means that DNA can be copied when cells divide.
- It is compact: folding of the molecule means a great deal of information can be packed into a small volume.


1
At the simplest level, chromatin is a double-stranded helical structure of DNA.
DNA double helix
2 nm
3
Each nucleosome consists of eight histone proteins around which the DNA wraps 1.65 times.
2
DNA is complexed with histones to form nucleosomes.
Nucleosome core of eight histone molecules
4
A chromatosome consists of a nucleosome plus the H1 histone.
H1 histone
11 nm
Chromatosome
6
... that forms loops averaging 300 nm in length.
300 nm
5
The nucleosomes fold up to produce a 30-nm fiber...
30 nm
250-nm-wide fiber
700 nm
1400 nm
7
The 300-nm fibers are compressed and folded to produce a 250-nm-wide fiber.
8
Tight coiling of the 250-nm fiber produces the chromatid of a chromosome.

# Fig. shows part of a DNA molecule.




(a) Name U, W and X.

U, W, X

(b) Name the bonds indicated by Z.

| Structure | Link to function |
| --- | --- |
| Genes and chromosomes | |
| DNA molecular structure (polymers) | |
| the anti-parallel nature of the strands; the asymmetric ends of DNA strands (the 5′ (*five prime*) and 3′ (*three prime*) ends, with the 5' end having a terminal phosphate group and the 3' end a terminal hydroxyl group); | |
| Double helix and complementary base pairing | |
| Sequence of bases making up the genetic code/Codon (covered in detail later); the coding and non-coding strands | |
| Packaging of DNA molecule-how and why? (protection etc) | |
| Histones | |